MACRO SENSORS™
Your sensor business partner...

EAZY-CAL™ LVC-4000

LVDT Signal Conditioner

CE

User Manual

Macro Sensors
7300 US Rt. 130 North, Bldg. 22.
Pennsauken, NJ 08110 U.S.A.
856.662.8000
www.macrosensors.com

Manual P/N 0653 0006 0000
Rev. E
July 3, 2013

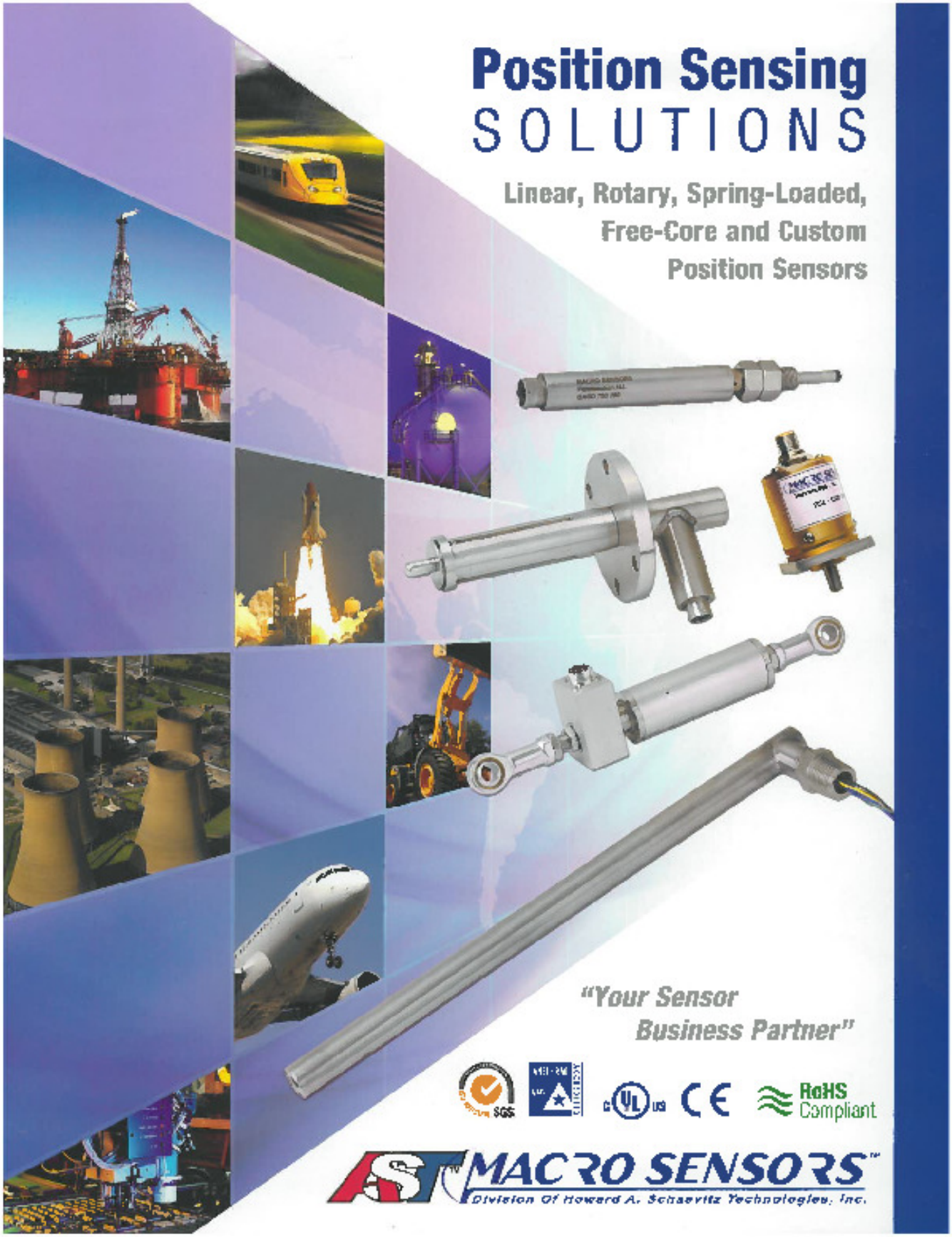

Position Sensing
SOLUTIONS
Linear, Rotary, Spring-Loaded,
Free-Core and Custom
Position Sensors
"Your Sensor
Business Partner"
RoHS
Compliant
MACRO SENSORS
Division Of Howard A. Schaevitz Technologies, Inc.

TABLE of CONTENTS

1 GENERAL DESCRIPTION 4

2 ELECTRICAL CONNECTIONS 5

3 FRONT PANEL 8

4 DIP SWITCHES 6

5 CALIBRATION PROCEDURE 9

5.1 Notes on Calibration 9

6 RS-485 DIGITAL INTERFACE 10

6.1 Command Format 10

6.2 Commands 11

7 SYNCHRONIZATION 12

8 ERROR DETECTION AND INDICATION 12

9 GENERAL SPECIFICATIONS 13

1 GENERAL DESCRIPTION

The EAZY-CAL™ LVC-4000 is a standalone signal conditioner, supporting a wide range of LVDTs, RVDTs and Half-Bridges and providing several choices of voltage, current, and digital RS-485 outputs. Push button calibration offers intuitive operation as compared to units with span and offset trim pots. Fault conditions such as a wire break on LVDT connections are indicated by blinking LEDs, output of an error voltage or current, and Error Flag Open Collector signal. The LVC-4000 operates from a 9 – 30VDC power supply and is housed in a polyamide DIN rail-mounted enclosure. Calibration instructions, terminal functions, LVDT connection diagram and DIP switch functions are printed on the side panels for convenience.

Synchronization to other signal conditioners is accomplished by a daisy chain connection to a synchronization bus. One unit will assume the Master function based on DIP switch priority setting. If a fault should occur, the next highest priority unit will take over as Master.

With the use of the RS-485 port, a host computer is able to retrieve measurement data, receive operational status, perform remote calibration and perform hot swap reconfiguration.

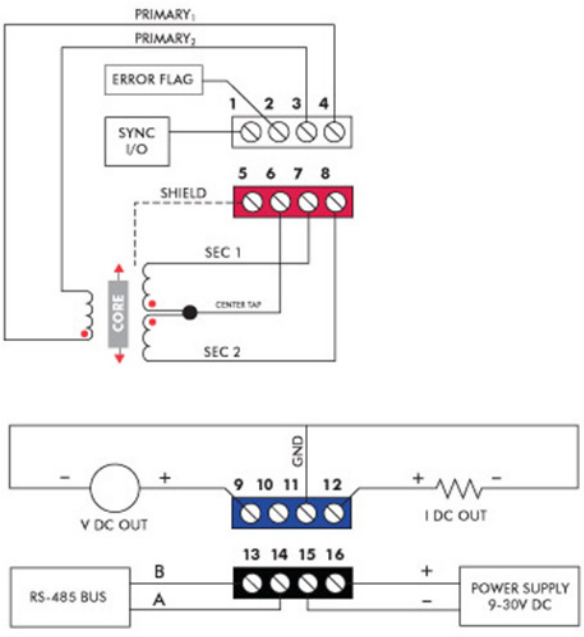
Hot swap is further simplified by the pluggable terminal block feature. An LVC-4000 can be quickly replaced in a live system without the need to unscrew terminal connections or sever connections between other signal conditioners.

The following sections describe the features and operation of the LVC-4000.

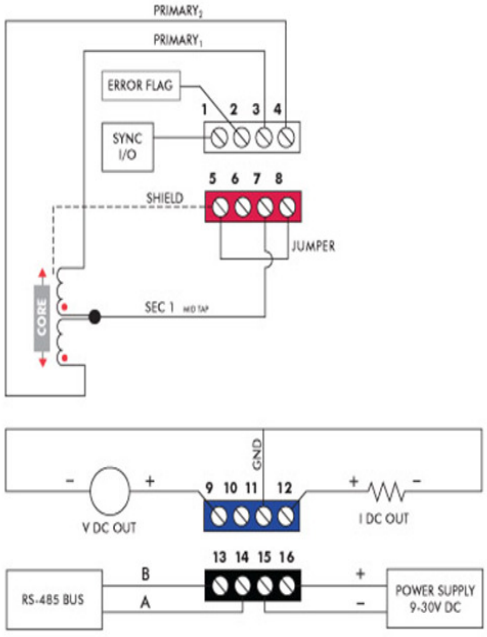
2 ELECTRICAL CONNECTIONS

There are four color coded terminal plugs, each having 4 screw terminals. The 16 terminals are labeled 1 through 16. Terminal plugs can be easily plugged and unplugged to facilitate LVC-4000 replacement in system. The terminal names and their function shown below:

Color	Terminal	Name	Function
White	1	SYNC I/O	Synchronization Master/Slave Input/Output
	2	ERROR FLAG	Error Flag Output
	3	PRI-1	Primary Excitation to LVDT
	4	PRI-2	Primary Excitation to LVDT
Red	5	SHIELD (GND)	Optional cable Shield connection
	6	SEC_CT	Optional Secondary CT conn. (n.c.)
	7	SEC-1	Secondary signal from LVDT
	8	SEC-2	Secondary signal from LVDT
Blue	9	VDC OUT	Output Voltage
	10	n.c.	No Connection
	11	GND	VOUT / IOUT Return
	12	IDC OUT	Output Current
Black	13	RS-485 B	RS-485 Data +
	14	RS-485 A	RS-485 Data -
	15	-VIN (GND)	Supply Voltage Return
	16	+VIN	Supply Voltage In



LVDT/LVRT Connection Diagram



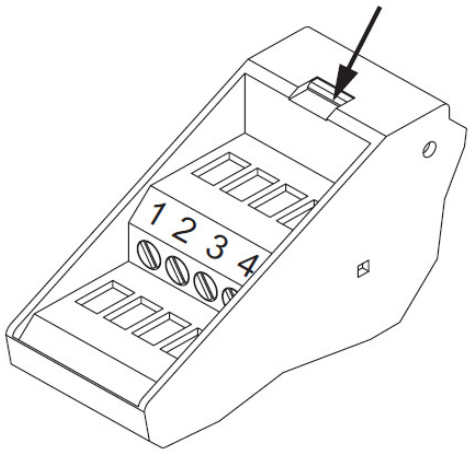
Half-Bridge Connection Diagram

Note – select either voltage (factory default) or current output using DIP SW1.

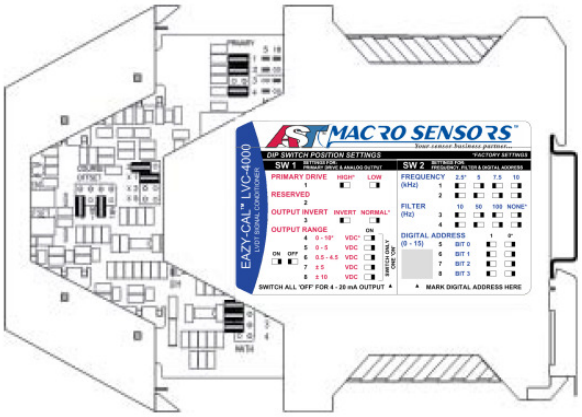
3 DIP SWITCHES

There are two 8-section DIP switches on the PCB. The switches provide selection of Primary Level, Excitation Frequency, Bandwidth, Output Voltage Range Select, Output Invert, and RS-485 Bus Address.

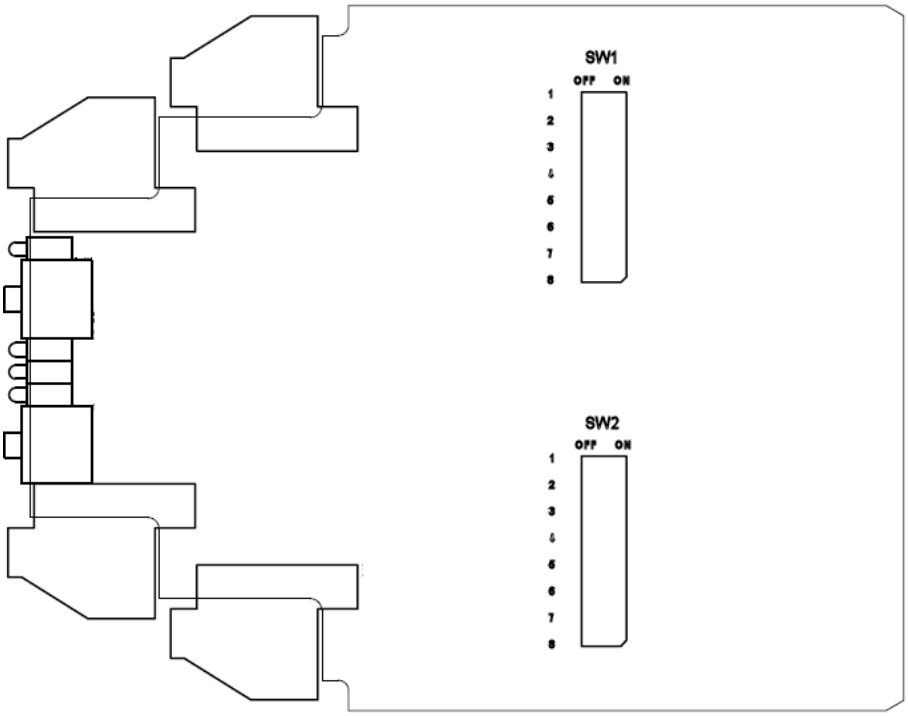
To access the DIP switches, the front cover and PCB must be withdrawn from the housing. Use a screwdriver or similar tool to depress the top latch. The cover will spring forward. Repeat with the bottom latch, then gently pull the PCB out, as shown:



Cover Release Latch



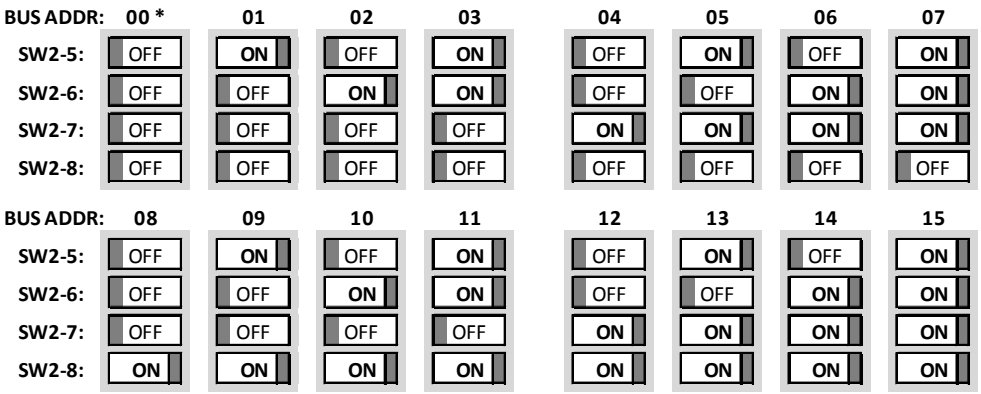
Withdraw PCB



The following table shows the control settings of the DIP switches:

FUNCTION	SWITCH - SECTION	SETTING			
Primary Drive Select between 3Vrms (High) & 1.5Vrms (Low) Excitation Output	SW1-1		Low OFF	High ON *	
Reserved No Function	SW1-2				
Output Invert Reverse the direction of Output vs. displacement	SW1-3		Normal OFF *	Invert ON	
Output Range Select one of five VDC outputs or the IDC output.	SW1-4 SW1-5 SW1-6 SW1-7 SW1-8 All Off:	0-10VDC * 0-5VDC 0.5-4.5VDC +/-5VDC '+/-10VDC 4-20 mADC		(Only 1 switch on at a time)	

Frequency Select one of four Excitation Frequencies		2.5KHz	5KHz	7.5Khz	10KHz
	SW2-1	OFF *	ON	OFF	ON
	SW2-2	OFF *	OFF	ON	ON
Filter Select one of 4 filter cutoffs		1Hz	10Hz	100Hz	none
	SW2-3	OFF	ON	OFF	ON *
	SW2-4	OFF	OFF	ON	ON *
Bus Address Select one of 16 RS-485 Bus Address via a 4 switch binary number. See table for switch combinations. (Also used to select order of Synchronization Master/Slave order.)			ON / OFF:		
	SW2-5	ADDR0 (lsb)	1 / 0		
	SW2-6	ADDR1	1 / 0		
	SW2-7	ADDR2	1 / 0		
	SW2-8	ADDR3 (msb)	1 / 0		

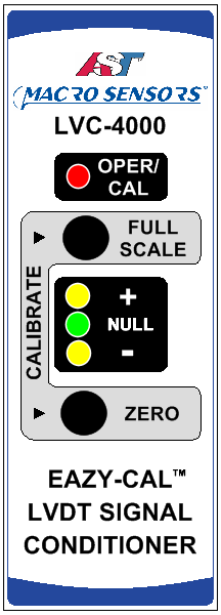

BUS ADDR: 00 * 01 02 03 04 05 06 07
SW2-5: OFF ON OFF ON OFF ON OFF ON
SW2-6: OFF OFF ON ON OFF OFF ON ON
SW2-7: OFF OFF OFF OFF ON ON ON ON
SW2-8: OFF OFF OFF OFF OFF OFF OFF OFF
BUS ADDR: 08 09 10 11 12 13 14 15
SW2-5: OFF ON OFF ON OFF ON OFF ON
SW2-6: OFF OFF ON ON OFF OFF ON ON
SW2-7: OFF OFF OFF OFF ON ON ON ON
SW2-8: ON ON ON ON ON ON ON ON

* - Factory default settings.

.

4 FRONT PANEL

The front-facing side of the enclosure contains the push buttons and LED indicators which are used for calibrating the LVC-4000 to the LVDT.



Front Panel Description	
OPER / CAL LED (Red)	On indicates Operating Mode, Blinking indicates Calibration Mode.
POSITION LEDs: **+** (Yellow) **NULL** (Green) **-** (Yellow)	During Calibration: '**+**' (Yellow) indicates core is above null position NULL (Green) indicates core is at null position '-' (Yellow) indicates core is below null position During Normal Operation: Error Condition: '**+**' (Yellow) blinking indicates Primary Wire Break '-' (Yellow) blinking indicates Secondary Wire Break Synchronization State: '**+**' (Yellow) indicates Slave mode NULL (Green) indicates Master mode
FULL SCALE / ZERO Buttons:	During Normal Operation: Press both buttons for 3 seconds to enter Calibration Mode During Calibration: Press ZERO button to set core minimum endpoint position Press FULL SCALE button to set core maximum endpoint position Press both buttons for 3 seconds to abort Calibration Mode

5 CALIBRATION PROCEDURE

Calibrating the LVC-4000 consists of entering Calibration Mode, finding the NULL (center) position of the LVDT, attaching the core to the object to be measured, and then moving the core to set the ZERO and FULL SCALE positions that will correspond to the minimum and maximum output voltage or current. The LVC-4000 returns to Operating Mode immediately after both positions have been set.

The basic calibration instructions are printed on the side of the LVC-4000 for reference.

Directions are as follows:

1. Set the LVC-4000 DIP Switches for the desired application. The factory default settings provide a 0 – 10VDC output, and are typical for most standard LVDTs. Refer to section 3.0 for details.
2. Connect the LVDT to the LVC-4000 as shown in the connection diagram and apply power. The OPER/CAL LED will light, along with the Green NULL LED (if the unit is in Master Sync mode), or the Yellow **+** LED (if the unit is in Slave mode). (3 minutes of warm-up time is recommended.)
3. Enter the Calibration Mode by pressing and holding both buttons simultaneously for 3 seconds minimum. The OPER/CAL LED will begin blinking.
4. Move the LVDT core to NULL position by observing the 3 Position LEDs. The **+** and **–** LEDs indicate that the core is inserted or extended beyond the NULL, respectively.
5. Attach the core to the workpiece to be measured so that the workpiece center of motion is aligned with the LVDT NULL.
6. Move workpiece to its minimum position and press the ZERO button. Wait for the Position LEDs to stop blinking.
7. Move workpiece to its maximum position and press the FULL SCALE button. The unit will exit Calibration Mode and operate with its new calibration. The OPER/CAL LED will be steady On.

5.1 Notes on Calibration

- It is important that the NULL position be set as close as possible to the center of the displacement range. Otherwise, non-linearity errors may result at or near the endpoint positions.
- The LVDT core MUST NOT protrude from the LVDT during the calibration, or erroneous calibration will result.
- Calibration may be performed by setting the FULL SCALE position first rather than ZERO position. Either end position may be on either side of NULL.
- Any portion of the LVDT specified displacement can be calibrated to produce a full output span. If the desired displacement is asymmetrical, set the endpoint that is farthest from NULL first.
- Swapping SEC-1 with SEC-2 or PRI-1 with PRI-2 LVDT connections will reverse the direction indicated by the Position LEDs.
- Calibration mode can be canceled by pressing the 2 buttons simultaneously for 3 seconds.

6 RS-485 DIGITAL INTERFACE

Included on the LVC-4000 is a 2 wire multi-drop RS-485 communications port. This allows a host computer to perform remote calibration, receive operational status and retrieve measurement data. Data can be exchanged between one or more units and a PC with a USB-to-RS485 adapter attached. A terminal program (Hyperlink) or 3rd party software is required. Port parameters are currently set to 9600 bps, no parity, 8 data bits and 1 stop bit (9600, NP, 8,1). Data is ASCII.

6.1 Command Format

Units respond to commands in the format:

:aa cmd param (CR)

where:

'*:*'	is the colon character,
'*aa*'	is the Unit Address 00..15, as set by the Digital Address DIP switches
'*cmd*'	is the command
'*param*'	is the optional command parameter
'(CR)'	is a carriage Return character

A space character is required between the address and command and between the command and parameter. Commands are not case sensitive.

6.2 Commands

The currently implemented commands and their descriptions are as follows:

`getConfig` - Shows the operating state of the unit and displays a list of all of the significant parameters, as shown in the example below:

```
        Macro Sensors LVC-4000 Configuration:
H/W Version         REV. --
F/W Version         0.7
Serial No.
Bus Address         0
Excitation Freq.    2.5KHz
Filter Select       NONE
Invert              NORM
Output Range        VOUT U10
ADC Slope           4.048681
ADC Offset          301
INA Gain            2
ADC Range           1
Sync State          MASTER
```

Note that the ADC Slope, ADC Offset, INA (Instrumentation Amplifier) Gain, and ADC Range parameters are computed during calibration, and can be downloaded into another unit. This allows for hot swap configuration, where a replacement unit can instantly function in place of the old unit without the need for rerunning the calibration process.

`getOut`	Returns nominal analog output value scaled in units that depend on the setting of the Output Range DIP switches.
`sADCsl`	Set the ADC Slope coefficient during hot swap reconfiguration.
`sADCos`	Set the ADC Offset coefficient during hot swap reconfiguration.
`cal`	Enter Calibration Mode
`getLEDs`	Get state of LEDs during calibration.
`setFull`	Set the Full displacement position during calibration.
`setZero`	Set the Zero displacement position during calibration.
`setINA`	Set the Instrumentation Amplifier gain during hot swap reconfiguration.
`abortCal`	Terminate the calibration procedure and go to Operate Mode. The LVC-4000 uses parameters which were in place before the start of the calibration.
`getError`	returns the error status.
`help`	Lists all the available LVC-4000 commands.

7 SYNCHRONIZATION

When multiple LVC-4000s share interconnecting wiring, interference may occur between them because of differences in excitation frequency. This may produce noise oscillations on the voltage or current outputs. In order to prevent this, the LVC-4000s can be synchronized with each other.

Synchronization of LVC-4000 signal conditioners is accomplished by connecting the SYNC I/O terminals of each unit into a daisy chain. One unit will assume Master Mode based on the priority set by the Digital Address DIP switches. With each unit set to a unique address, the lowest addressed unit becomes Master. All other units enter Slave Mode. If the current Master ceases to function, the next consecutively-addressed unit enters Master Mode without user intervention. If a unit is hot swapped or reconnected, it will enter Slave Mode. In an interconnected group of units, one and only one LVC-4000 is guaranteed to be Master, even if duplicate addresses exist.

Synchronization mode is indicated by the '+' (Yellow) LED for Slave Mode, and the NULL (Green) LED for Master Mode.

8 ERROR DETECTION AND INDICATION

The LVC-4000 detects and reports operational failures, including broken connections to the LVDT Primary and Secondary windings. Error conditions are indicated as follows:

LEDs:

Primary Open condition is indicated by a blinking '**+**' (Yellow) LED.
Secondary Open condition is indicated by a blinking '**-**' (Yellow) LED

Error Flag:

The Error Flag is an Open Collector output signal requiring an external pullup resistor. The output is low (transistor turned on) during normal operation, and high (turned off) for any error condition.

Error Output Voltage or Current Level:

An error condition causes the LVC-4000 Voltage or Current Output to go to a level outside of the measurement range. For 0-10 VDC or 0-5 VDC ranges, the error voltage is -0.5 VDC and -0.25 VDC respectively. For 4-20 mADC range, the error current is 0 mADC.

RS-485 Bus:

The `getError` command returns the error status.

9 LVC-4000 GENERAL SPECIFICATIONS

Parameter	Value	Comment
Power:		
Input Voltage	9-30 VDC, 90 mA max @ 24 VDC	
Excitation:		
Primary Voltage (nominal)	3 Vrms (1.5 Vrms selectable)	
Primary Current	30 mA max	
Primary Impedance	90Ω min (@ 1.5 Vrms)	
Primary Frequency	2.5 kHz, 5 kHz, 7.5 KHz or 10 kHz	
Signal Output:		
Voltage Output	0-10 VDC, 0-5 VDC, 0.5-4.5 VDC, ±5 VDC, or ±10 VDC, selectable	
Current Output	4 - 20 mADC	
Loop resistance	1KΩ max. with 24 V DC supply	
Frequency Response	500Hz Max	
Low Pass Filter	1Hz, 10Hz, 100Hz or none, selectable	
Output Voltage Ripple	1 mV rms max (2.5KHz Excitation, no Filter) 2 mV rms max (10KHz Excitation, no Filter)	
Output Current Ripple	10 µA rms max (2.5KHz Excitation, no Filter) 20 µA rms max (10KHz Excitation, no Filter)	
Output Non-Linearity	< ±0.1% of FSO	
Environmental:		
Temp. Co. Gain	<0.02% FRO/°C	
Temp. Co. Offset	<0.02% FRO/°C	
Operating Temperature Range	-20°C to 75°C	
Enclosure	4.5 x 3.9 x .9 in., Green	
EMC Compliance	Emissions: EN55011:2007 Immunity: EN61000-4-2:2009, EN61000-4-4:2004, EN61000-4-6:2009, EN61000-4-3:2010+A2:2010	
Features:		
Synchronization Capability	Master/Slave Synchronization via single wire bus.	
Automatic Calibration	Via Front Panel Push Button or RS-485 command	
Null Detection	Via Front Panel LEDs or RS-485 command	
Digital interface	RS-485 2-wire multi-drop network, 16 addresses selectable	
Error Detection	Primary or Secondary Wire Break Detect, indicated by LED, Error Flag, and Error Output Level	
Error Flag	Open collector output, 50 mA, 30 V DC max.	

Some of our business partners are...

AST MACRO SENSORS™
Division Of Howard A. Schaevitz Technologies, Inc.

7300 US Route 130 North, Bldg. 22
Pennsauken, NJ 08110-1541 USA
tel: 856-662-8000
fax: 856-317-1005
www.macrosensors.com
lvdts@macrosensors.com

All specifications subject to change without notice.
© 2012 Macro Sensors 05/12